cessing board, then the image data are analyzed by software that implements the present machine-vision technique. This analysis results in the identification of cells that are "good" candidates for patch clamping (see figure). Once a "good" cell is identified, a patch clamp can be effected by an automated patch-clamping apparatus or by a human operator.

This technique has been shown to enable reliable identification of "good" and "bad" candidate cells for patch clamping. The ultimate goal in further development of this technique is to combine artificial-intelligence processing with instrumentation and controls in order to produce a complete "turnkey" automated patch-clamping system capable of accurately and reliably patch clamping cells with a minimum intervention by a human operator. Moreover, this technique can be adapted to virtually any cellular-analysis procedure that includes repetitive operation of microscope hardware by a human.

This work was done by Mark McDowell of Glenn Research Center and Elizabeth Gray of Scientific Consulting, Inc. Further information is contained in a TSP (see page 1).

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17902-1.

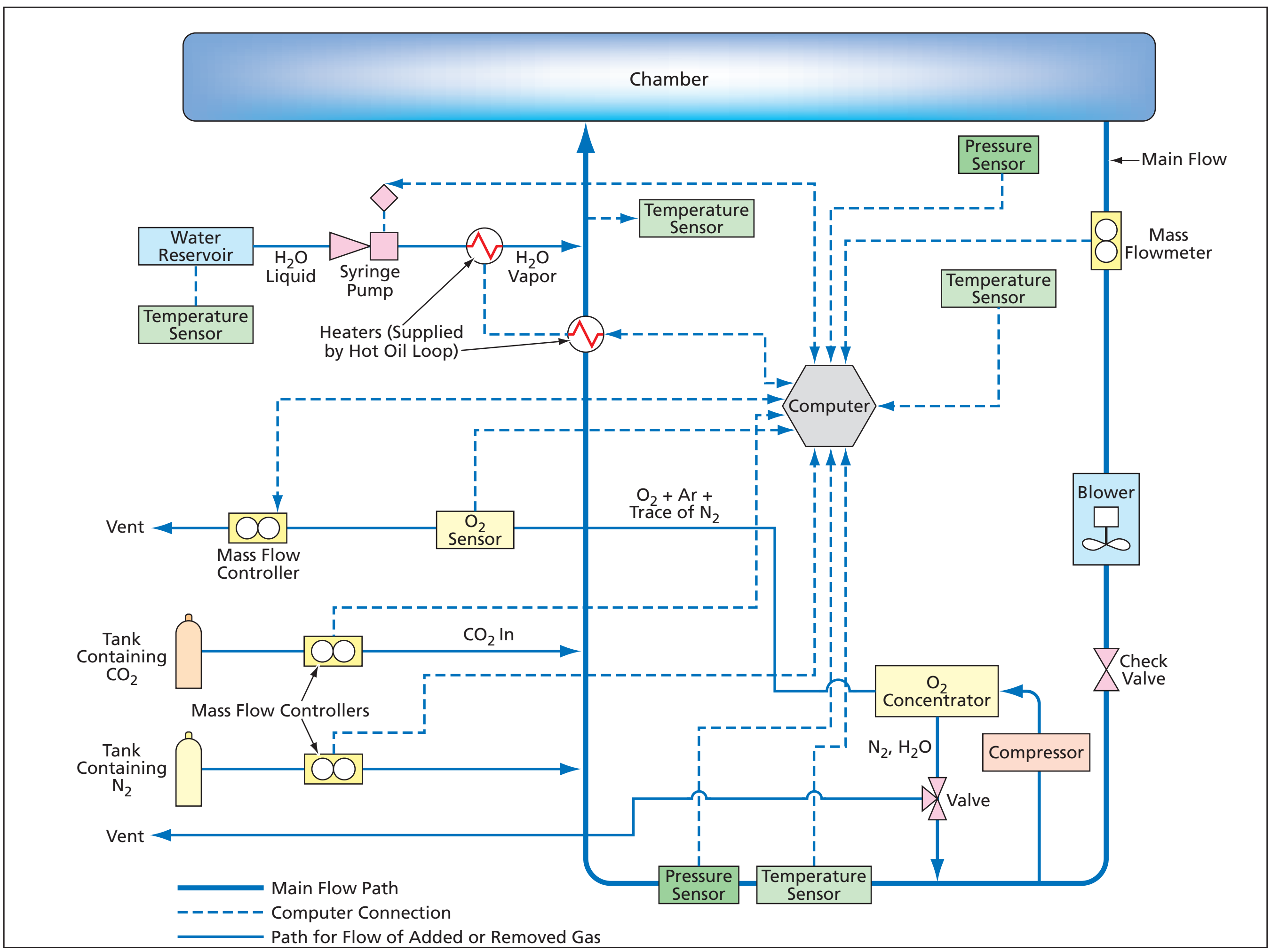
Redesigned Human Metabolic Simulator

Apparatus simulates atmospheric effects of human respiration.

Lyndon B. Johnson Space Center, Houston, Texas

A design has been formulated for a proposed improved version of an apparatus that simulates atmospheric effects of human respiration by introducing controlled amounts of carbon dioxide, water vapor, and heat into the air. Denoted a human metabolic simulator (HMS), the apparatus is used for testing life-support equipment when human test subjects are not available.

The prior version of the HMS, to be replaced, was designed to simulate the respiratory effects of as many as four persons. It exploits the catalytic combustion of methyl acetate, for which the respira-



The **Improved HMS** would remove O_2 while adding CO_2, H_2O, and heat in amounts chosen to simulate the respiratory effects of as many as eight humans at various levels of activity.

tory quotient (the molar ratio of carbon dioxide produced to oxygen consumed) is very close to the human respiratory quotient of about 0.86. The design of the improved HMS provides for simulation of the respiratory effects of as many as eight persons at various levels of activity. The design would also increase safety by eliminating the use of combustion.

The improved HMS (see figure) would include a computer that would exert overall control. The computer would calculate the required amounts of oxygen removal, carbon dioxide addition, water addition, and heat addition by use of empirical equations for metabolic profiles of respiration and heat.

A blower would circulate air between the HMS and a chamber containing a life-support system to be tested. With the help of feedback from a mass flowmeter, the blower speed would be adjusted to regulate the rate of flow according to the number of persons to be simulated and to a temperature-regulation requirement (the air temperature would indirectly depend on the rate of flow, among other parameters).

Oxygen would be removed from the circulating air by means of a commercially available molecular sieve configured as an oxygen concentrator. Oxygen, argon, and trace amounts of nitrogen would pass through a bed in the molecular sieve while carbon dioxide, the majority of nitrogen, and other trace gases would be trapped by the bed and subsequently returned to the chamber. If, as recommended, the oxygen concentrator were of a rotating twelve-bed design, then variations in the product stream could be made very small.

Carbon dioxide would be added directly to the circulating air by simple injection from a supply tank. The rate of injection would be maintained at the required rate by use of a mass flowmeter/controller. In the same way, nitrogen would be added to make up for the small amount of nitrogen lost through the oxygen concentrator.

Water vapor would be added to the circulating air by heating the corresponding required flow of water to steam in a heat exchanger. More heat, required to complete the simulation of the thermal effect of respiration, would be added through another heat exchanger. Heat would be supplied to both heat exchangers via a hot-oil loop.

This work was done by Bruce Duffield, Frank Jeng, and Kevin Lange of Lockheed Martin Corp. for Johnson Space Center.

This invention is owned by NASA, and a patent application has been filed. Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-23846.